



California Department of Fish and Game

The Threat from Northern Pike in Lake Davis to California's Fisheries and How Rotenone is Used to Help Manage Our Fishery Resources



Photo © Cowles 1996

The highly predaceous northern pike consuming a juvenile fish.

This article discusses the threat posed to California's fisheries by aggressive, non-native northern pike and the impact of the proposed use of rotenone to eradicate this species from the Lake Davis area. The fisheries of concern are Lake Davis, the Feather River, Lake Oroville, the lower Sacramento River and the Sacramento-San Joaquin Delta. Detailed information is also presented on the use of rotenone in fishery resource management, testing and research that has been done, and precautions that would be taken to assure the safety of people and the environment. It is hoped that this information will help you understand the damage that northern pike can inflict on the California aquatic environment and the reasons for choosing rotenone as a fish-control agent for the Lake Davis area.



Photo by Danny OConnell

Dr. John Long and a 22" rainbow trout from Lake Davis.

Introduction

Americans love to go fishing! In fact, we love it so much that, each year, more than one-fourth of the total U.S. population travel with fishing poles in hand to enjoy our streams, rivers, ponds, lakes, and oceans. That's more than 60 million people spending countless hours and more than \$28 billion dollars annually in pursuit of America's favorite pastime...and that number is growing.

These fishing enthusiasts bring increased expectations and demands to already heavily impacted aquatic areas.

California's Department of Fish and Game is entrusted with the task of maintaining a healthy aquatic environment, protecting our waterways from misuse and predation, and



Photo © Cowles 1996

Northern pike in action.



DFG Photos Debra Hamilton

This rainbow trout was attacked by a northern pike as a fisherman was landing him at Lake Davis.



balancing the demands made on this finite natural resource by commercial, residential, recreational, and environmental activities. Active intervention may be required to maintain a healthy aquatic balance, such as the planting of desirable fish or the eradication of non-native and/or exotic predators that threaten an ecosystem.

A healthy aquatic ecosystem exists only as long as the balance of predator and prey is maintained. When a non-native predator is introduced into aquatic ecosystems, the results can be catastrophic.

Northern pike are long-lived, fast-growing exotic fish that do not naturally occur west of the Rocky Mountains. They prey primarily on other fish, including trout, but will also eat frogs, crayfish, goslings, and ducklings. The introduction of pike into other western lakes has resulted in the destruction of sports fisheries and the natural balance of these areas. Pike spread rapidly and present a continuing hazard to adjoining watersheds.

In 1994, northern pike were found in Lake Davis. These fish probably originated in Frenchman Reservoir and were illegally planted here several years earlier. (Pike were eradicated from Frenchman Reservoir in 1991.) Lake Davis is a man-made reservoir, constructed by the Department of Water Resources in the 1960s, and stocked with hatchery rainbow trout. Besides ruining the trout fishery in Lake Davis, these pike also serve as a source for additional illegal planting into other bodies of water and threaten the stability of adjoining waterways. Lake Davis empties into the Sacramento-San Joaquin Delta via the Feather River and Sacramento River and it is feared that the northern pike will move downstream into these areas. They could prey upon the already depleted and stressed populations of steelhead trout, chinook salmon, delta smelt, and Sacramento splittail. This additional predation could threaten and eventually cause the extinction of these species. Because of the ecological damage already evident in the immediate area, and the potential danger to adjacent fisheries, all the northern pike must be removed from Lake Davis.

Control Options

Fishery managers have several options to consider for removing an undesirable, exotic species from a lake or stream. If circumstances permit, the body of water can be drained to remove the fish. However, in streams and many lakes (including Lake Davis), this is not a viable option. The approach most commonly used in similar situations is to apply a fish control agent to kill all of the target fish population and then restock the treated area with desirable game species as soon as possible. In the case of Lake Davis, the northern pike would be eradicated and the lake restocked with rainbow trout.

The Department of Fish and Game is aware of and shares the concern of the people of the State of California over the use of chemicals in our natural environment. However, many chemicals serve a very useful purpose and, when used properly, can actually assist in restoring the natural balance. By identifying the most effective control agent for the situation and carefully evaluating any potential problems or contra-indications for that product, it is possible for the fisheries manager to choose the appropriate application. They can then take the precautions necessary to achieve their goals while protecting the environment, people, and non-targeted animals residing in the surrounding areas.

When considering the type of fish control agent to be used, managers must determine that the chemical will work quickly, break down in a short time, and leave no harmful residues. It must not pose a health hazard to those applying or coming into contact with the substance, or to animals or birds that might consume treated water. It also must not adversely affect aquatic



Lake Davis empties into the Sacramento-San Joaquin Delta and it is feared that the northern pike will move downstream into these areas, preying upon the already depleted and stressed populations of steelhead trout, chinook salmon, delta smelt, and Sacramento splittail.

plants. After application, the control agent must break down quickly and completely so that populations of nontargeted organisms (zooplankton and other invertebrates such as insects and copepods) can recover from any negative impact and restocking of trout may begin.

Photo © Cowles 1996



The northern pike.

Use of Rotenone

The primary concern raised by local citizens at both Lake Davis and areas where rotenone has been used in the past is: "Has rotenone been adequately tested to assure our personal safety and protect the environment?" The answer is: "Yes."

Rotenone is a natural substance derived from several tropical and sub-tropical plants. Natives in Central and South America have used the juices from the roots of these plants for centuries to help them collect fish for food. The technique they used was pound the root between rocks (or other objects), then throw the entire plant into the water. They would then collect the fish that floated to the surface and eat them.

The dried roots of rotenone-producing plants can be ground into a powder that is useful as a garden insecticide. For many years, it has been widely used as an agricultural insecticide in the U.S. and was applied to crops and livestock to control insect pests. Today, growers can use rotenone and still have their produce certified as "organic." Rotenone is so safe to humans that it is exempt from tolerance on fruits and vegetables.

Rotenone offers an effective means of eradicating a predatory species and protecting extensive portions of our state's waterways without endangering the surrounding habitat. It is also a quick, efficient first step in restoring the natural ecological balance in the Lake Davis area.

Rotenone: The Approval Process

Rotenone is a fish control agent that has been used safely and effectively in the reclamation of California's ponds, lakes, and rivers for more than 25 years. Rotenone is available as a powder or liquid. The liquid formulations are more commonly used since they contain emulsifiers, dispersants, and solvents to assure that the rotenone is quickly dispersed throughout the body of water. This helps to achieve an effective treatment. The emulsifiers, dispersants and solvents are classified as "inert ingredients" by the EPA.

The emulsifiers and dispersants in the liquid formulations are petroleum-based and biodegrade more quickly than rotenone. Therefore, by the time the treated water is ready for restocking with game fish, both rotenone and these other materials have biodegraded. They are also approved for use by the EPA.

EPA approval of chemical fish control agents is required prior to use. Prior to approval by the EPA, research must have been conducted to show that the product:

1. does not have a long-term effect on human or animal life;
2. has no long-term effect on the environment or on other forms of life, other than the one it is supposed to control;
3. does not leave persistent residues;
4. does not join with other chemicals to form a new chemical with hazardous effects; and
5. does not constitute a health hazard to humans working with the chemical.

The U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (DFG) have conducted extensive testing of rotenone over

the past 25 years. Over \$3,000,000 has been invested in developing the data required by EPA as part of its evaluation process. Thus, rotenone is EPA approved for use as a fish control agent.

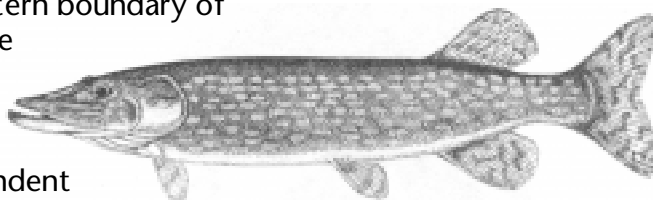
Questions & Answers on the Lake Davis Pike Eradication Project

Q. What are northern pike and why are they considered a threat?

- A. Northern pike belong to the family of fishes which includes muskellunge and pickerel. Pike are elongate, tubular fish with large, strongly protruding, flattened heads and very large mouths with spine-type teeth. Northern pike are native to the Great Lakes states with the Missouri River system marking the western boundary of the native range. Pike are top predators with fish, frogs, crayfish, goslings, and ducklings as their primary diet. An independent review panel from the American Fisheries Society (AFS) stated that "top predators such as pike can prey on salmon and native minnows and can seriously and negatively alter ecosystems." The AFS "strongly recommended the **immediate eradication of pike**," and "every day that goes by increases the probability that pike will escape the lake."



Spine type teeth of the northern pike.



Q. Why is the State of California concerned about the detrimental effects of pike on native salmon when highly predaceous, nonnative striped bass already inhabit the Sacramento-San Joaquin Delta?

- A. While it is true that striped bass are non-native and predaceous fish, the habits and impacts of northern pike are considerably different. Striped bass live their adult life in estuarine and marine waters and prey on anchovies, herring, shiner perch, smaller striped bass, and other fish. Few striped bass reside in fresh water throughout their life. Only when in fresh water do striped bass prey on invertebrates and other fish. In contrast, both juvenile and adult pike spend their entire existence in fresh water where young salmon and other freshwater fishes are resident. We thoroughly expect salmon and other fish to decrease in abundance as a result of predation by pike. Northern pike have consistently destroyed the forage base and eliminated other predators such as largemouth bass when introduced into new habitats.

Q. Have northern pike been found outside of Lake Davis?

- A. Northern pike were found in Frenchman Lake until 1991 and in the Middle Fork Feather River in Sierra Valley in 1991 and 1992. The DFG has eradicated the northern pike from these areas. Recently, the DFG received an unqualified (not confirmed by a biologist) report of a northern pike at the State pumping plant in the Sacramento-San Joaquin Delta. Although this is alarming, we have no sure way of determining if it was a northern pike. Regardless, a single northern pike does not mean that this species has established a reproducing population elsewhere in California. (See page 14)



DFG Photo by Gary Miller

Q. Why not get rid of the northern pike by other means?

- A. The Department of Fish and Game reviewed several alternatives to the use of rotenone. These included biological controls, dewatering, blasting, water fluctuation, and physical removal using a variety of

DFG photo by Debra Hamilton



Northern pike from Lake Davis.

devices. None of these options provided the assurance of eradicating the pike from Lake Davis or other infested areas, an action deemed essential to the continued survival of the California native fish.

Q. Why use a chemical fish control agent?

- A. Use of a fish control agent enables managers to eradicate fish without endangering non-targeted wildlife and then re-establish the desired population of fish. Although other approaches are useful in special circumstances, they are only partially effective.

Q. What are rotenone and Nusyn Noxfish®?

- A. Rotenone is a natural substance contained in the stems and roots of certain tropical plants, such as the Jewel Vine or Flame tree (*Derris* spp.), Lacepod (*Lonchocarpus* spp.), or hoary pea (*Tephrosia* spp.). Rotenone is very water insoluble (i.e., like oil), and chemicals must be used to disperse it in deep lakes. Nusyn Noxfish® is one of several formulated products containing emulsifiers and dispersants designed to disperse rotenone throughout the water body. This assures a complete exposure of the target species to the rotenone.

Q. Does rotenone have other names?

- A. Many products are sold that contain rotenone. Brand names include Chem-Fish, Cube', Derrin, Derris root, Fish-Tox, Nicoulins, Nusyn Noxfish, Prentox, Noxfish, rotenone dust, and Timbo powder.

Q. Is rotenone a selective pesticide?

- A. It is selective to fish and other gill-breathing organisms at the concentrations used by fishery biologists. In general, most common aquatic invertebrates are less sensitive than fish to rotenone but some of the zooplankton (cladocerans and copepods) are equally sensitive. However, studies have shown that zooplankton are able to quickly re-populate an area when the toxicity ends. Snails and clams are quite tolerant. Pike, trout, and salmon are the most sensitive of the fish species, sunfish are less sensitive, and catfish are the most resistant. In Lake Davis, the concentration of rotenone will be high enough to kill all the pike and trout, but some of the bullhead catfish may survive.

Q. What other uses are there for rotenone?

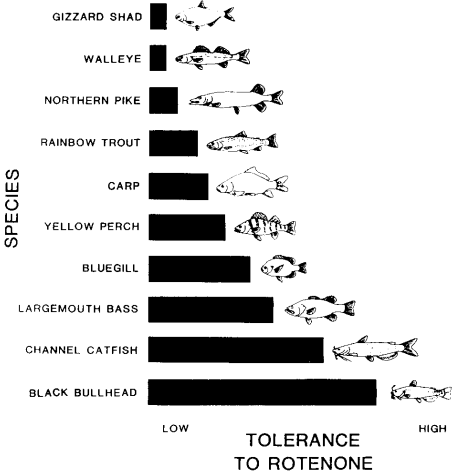
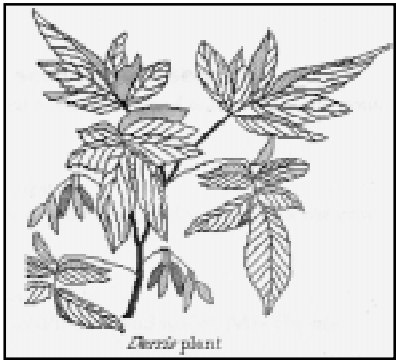
- A. In addition to its use as a fish control agent, rotenone is effective as an "organic" garden insecticide to control chewing insects, as a dog and sheep dip, and has been used as a dust on cattle.

Q. Have rotenone and Nusyn-Noxfish® been used in other domestic water supplies other than Lake Davis?

- A. Nusyn-Noxfish® was used by the DFG to eradicate white bass in the Friant-Kern Canal in 1985. There were seven municipalities which received domestic water from the Friant-Kern Canal, serving over 200,000 people in the Central Valley. During the time Nusyn-Noxfish® was present in the water, the intakes to the water treatment facilities were turned off, similar to what is planned for Lake Davis. Several other states have also used Nusyn-Noxfish® and similar formulated rotenone products in domestic water supplies with similar restrictions for years. No significant problems have been noted.

Q. How does it work?

- A. Rotenone interferes with the fish's ability to use oxygen during



DFG photo by Gary Miller



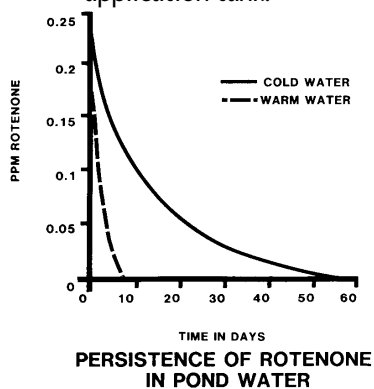
Frenchman Lake project staging area.



Loading rotenone barrels onto application boat.



Loading rotenone into application tank.



Applying rotenone (Nusyn-Noxfish®).



Applying rotenone (Nusyn-Noxfish®).

DFG photos by Gary Miller



Detoxification using potassium permanganate.

respiration. It does not, as previously believed, suffocate the fish or prevent the uptake of oxygen into the bloodstream.

Q. How is rotenone applied?

- A. Rotenone is applied as an emulsifiable concentrate and generally injected below the water surface from boats. The shallow areas near the shore are sprayed.

Q. What happens to rotenone after it has been applied?

- A. Rotenone is a compound that breaks down very rapidly when exposed to light, heat, oxygen, and alkaline water. Ultimately, rotenone breaks down into carbon dioxide and water. The other compounds in Nusyn-Noxfish® break down even more quickly than rotenone.

Q. How long does it last?

- A. At 60°F (the temperature of Lake Davis in late September and early October), the toxicity to fish may last for up to two weeks. Generally, most lakes treated with rotenone completely detoxify and all chemical residues dissipate within 4 weeks of treatment. The compounds in liquid rotenone formulations will degrade rapidly with exposure to light, heat, oxygen, and alkaline water.

Q. How much rotenone, emulsifiers, and dispersants will be present in Lake Davis and for how long?

- A. Rotenone (i.e., Nusyn-Noxfish®) is normally applied at a concentration of 2 parts per million (ppm). Two ppm is roughly equivalent to 1.3 ounces of Nusyn-Noxfish® in a 5,000 gallon swimming pool. This amount of formulated rotenone will result in maximum concentrations in water for rotenone of 0.05 ppm, naphthalene of 0.14 ppm, methylnaphthalene of 0.17 ppm, xylene of 0.003 ppm, and trichloroethylene (TCE) of 0.001 ppm. Monitoring of rotenone applications in California reservoirs has shown that these materials will completely disappear within two to four weeks, depending on water temperature. We plan to treat Lake Davis at the above concentration.

Q. Can the toxic effects of rotenone be neutralized?

- A. Biologists can neutralize the effects of rotenone in lakes or rivers with potassium permanganate. This will be done at the dam outflow to Big Grizzly Creek to protect the trout inhabiting the downstream waters.

Q. Is formulated rotenone likely to enter ground water and pollute water supplies?

- A. No. According to the Department of Water Resources, none of the wells around Lake Davis are connected to Lake Davis. Additionally, the ability of rotenone to move through soil is low to slight. Rotenone moves only 2 cm (less than one inch) in most types of soils. An exception would be in sandy soils where the movement is about 8 cm (slightly more than 3 inches). Rotenone is strongly bound to organic matter in soil so it is unlikely that rotenone would enter ground water, even if it had not degraded. The other compounds in formulated rotenone are not present long enough to pollute ground water. Monitoring of domestic wells adjacent to surface water bodies treated with formulated rotenone have shown that none of the compounds have entered ground water.

Q. What is the danger associated with accidentally drinking rotenone-treated water?

- A. The hazard associated with such an event is very slight at the

concentrations used for this treatment. For example, a 132 pound person would have to drink over 60,000 liters (15,790 gallons) of treated water at one sitting to receive a lethal dose. When a 1,000-fold safety factor is included, a person could drink 14 quarts of treated water per day for a lifetime and still be well below the most conservative safe intake level. In the case of Lake Davis, the lake will be closed during and after treatment as long as residue is present. This eliminates all risk to humans because they will not come in contact with residues.

Q. How can rotenone be used in a public drinking water supply, such as Lake Davis, without persistent or serious health consequences?

- A. Lake Davis will be treated late in the year to minimize the impacts on domestic water use. During the treatment and for the period of time that any chemical residues are present alternate water sources will be provided. Following this two-to-four week period, Lake Davis water will again be usable as drinking water. The arrangements for the alternate water supply have been approved by the California Department of Health Services (DHS). The reuse of Lake Davis water after the treatment will follow approval by DHS.

Q. What public health effects will result from the Nusyn-Noxfish®?

- A. The Department of Pesticide Regulation (DPR) said that "the use of Nusyn-Noxfish does not pose long-term health risks to citizens because there will not be significant exposure to either the active or 'inert' ingredients." In their assessment of the treatment plan for Lake Davis, DHS scientists said "the proposed use of rotenone does not pose any threat to public health and safety so long as an alternate water supply was provided and Lake Davis was not used as a drinking water supply until all chemical residues had dissipated." The DHS said further that, "they do not anticipate that the use of rotenone will pose long-term health concerns to the citizens who use Lake Davis for their drinking water."

Q. Nusyn-Noxfish® contains the carcinogen trichloroethylene (TCE). Does this present a risk to human health?

- A. Nusyn-Noxfish® contains only minute quantities of TCE, and concentration levels in Lake Davis water immediately following treatment (0.001 ppm) will still be below the level permissible in California drinking water (0.005 ppm). Chlorinated drinking water and bodies of water with heavy motorboat traffic often contain detectable levels of carcinogens, like trihalomethane and benzene. California safe drinking water standards established permissible levels for these and other chemicals. As long as the concentration is below the level permitted, the water is safe.

Q. How will we know it is safe to restock fish and allow public contact with the water?

- A. Chemical analysis will be used to determine how much rotenone and other compounds are present. The results will be evaluated by the Department of Health Services. As an additional precaution, Lake Davis will be closed to the public until all chemicals have dissipated. Therefore, there will be no exposure to the public from any of the chemicals in the formulated rotenone.



Northern Pike from Lake Davis.



Northern pike from Lake Davis.

Q. How soon can we expect fishing to improve after a rotenone treatment?

- A. Fish stocking will begin as soon as biologists determine that it is safe to re-introduce trout to the lake. The treatment will be in the fall of the year, so small fish will be stocked and will grow to catchable size by the next spring. Additionally, 10,000 pounds of trophy size rainbow trout, 50,000 catchable rainbow trout, and 700,000 fingerling rainbow trout will be planted the following spring. Expect Lake Davis to have excellent fishing the year after the treatment and for many years to come.

Q. How soon can people enter the treated water?

- A. The EPA has concluded that there is no reason to restrict the use of rotenone in waters intended for recreational swimming. However, as an additional precaution, we will close Lake Davis to public contact until all chemical residues have dissipated.

Q. Does rotenone affect all aquatic animals the same?

- A. No. Fish are more susceptible. All animals including fish, insects, birds, and mammals have natural enzymes in the digestive tract that detoxify rotenone. However, fish are highly susceptible because rotenone is readily absorbed directly into their blood through their gills, bypassing the digestive enzymes. The other ingredients in Nusyn-Noxfish® will impart no toxicity to fish, insects, birds, or mammals at proposed application rates.

Q. Will wildlife which eat dead fish and drink treated water be affected?

- A. Birds and mammals which eat dead fish and drink treated water will not be affected. A bird weighing 1/4 pound would have to consume 100 quarts of treated water or more than 40 pounds of fish and invertebrates within 24 hours to receive a lethal dose. This bird would normally consume 0.2 ounces of water and 0.32 ounces of food daily; thus, a safety factor of 1,000 to 10,000- fold exists for birds and mammals. No latent or continuing toxicity is expected since none of the compounds will persist for longer than four weeks. Mammals and birds that ingest rotenone by drinking treated water or by eating dead fish would simply digest it without any toxic effect.

Q. Is it safe for livestock to drink from rotenone-treated ponds or lakes?

- A. Rotenone has been used for many years to control grubs on the backs of dairy and beef cattle. The EPA has stated that there is no need to restrict livestock consumption of treated waters.

Q. What impacts will the dead and decaying fish have on the recovery of fishing in Lake Davis or its use as a domestic water supply?

- A. The DFG will pick up and dispose of as many dead fish as possible. These fish will be taken to a rendering plant and made into fertilizer. Those remaining will fall to the bottom of the lake in several days, decompose, and release nutrients back into the water. This will stimulate phytoplankton and indirectly stimulate zooplankton production (a food base for trout) the next spring. Because the water intake is near the lake surface, and the water treatment plant's activated charcoal filter is capable of removing offensive tastes and odors, no problems are anticipated.

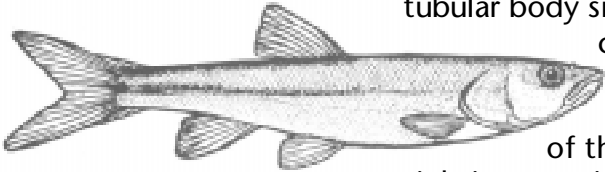
DFG Photo by Debra Hamilton



Sunset at Lake Davis.

Q. What should I do if I see or catch a northern pike? What are some of the closely related or “look-alike” species that might be mistaken for northern pike?

- A. The DFG is concerned about northern pike spreading beyond their current confined area of Lake Davis. Anybody catching a fish resembling a northern pike should call DFG immediately at (916) 358-2900. The Department will send a qualified biologist to investigate and identify each “pike” reported. Anglers have mistaken the fish commonly known as Sacramento squawfish or Sacramento pike as a northern pike. This fish is actually a minnow, native to the Sacramento River drainage. They have a tubular body similar in shape to a northern pike, but lack the green coloration, large head, and spine teeth. Other fish which have been mistakenly identified as northern pike by anglers include green sunfish and brook trout. With the exception of the one possible sighting mentioned above, northern pike are still believed to be contained to Lake Davis.



Q. Where can I obtain more information about fishery uses of rotenone and its effects on the environment?

- A. The best source of information on rotenone and its effects on the environment is the 1994 Final EIR (Subsequent) *Rotenone Use for Fisheries Management-July 1994 (SCH92073015)* written by the California Department of Fish and Game. This document has been cited by the U.S. Environmental Protection Agency and environmental agencies in Europe as the authoritative reference for environmental impacts of rotenone use in fisheries management. Copies can be obtained from the California Department of Fish and Game, Pesticide Investigations Unit, 1701 Nimbus Road, Suite F, Rancho Cordova, California 95670.

For updated information on the Lake Davis northern pike eradication project, call (916) 358-2900.

Originally written as *Better Fishing Through Management* by R. Sousa, F. Meyer, and R. Schnick, U.S. Fish and Wildlife Service; this version has been updated and edited by the California Department of Fish and Game and S. Raab. Used by permission.



This rainbow trout was attacked by a northern pike as an angler was trying to land it at Lake Davis.



DON'T MOVE LIVE NORTHERN PIKE

HELP PROTECT OUR FISHERY RESOURCES

Section 5.51 Northern pike. No northern pike may be possessed at any time. Any northern pike taken must be released immediately into the water where taken.

If you see someone transporting live northern pike, please contact the toll-free CalTIP hotline immediately, 24 hours a day, seven days a week.

You may remain anonymous. Please be prepared to relay information such as license numbers, description of suspects, and names if known.



**REPORT VIOLATIONS TO
1 888 DFG-CALTIP**

